ARI Newsletter

U.S. Army Research Institute for the Behavioral and Social Sciences

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Need to know quickly soldiers' opinion on "hot topic" issue? **Army ✓ Fast Tracker** may be the solution!

Army ✓ Fast Tracker is a total package for conducting scientifically sound surveys, using the Internet. ARI's systematic approach for ✓ Fast Tracker includes combining a dependable software package with standard survey methods, thereby enabling personnel surveys that fully meet fully all Army and industry survey standards for scientifically sound surveys.

Army ✓ Fast Tracker can provide survey results within 6-7 weeks. When a panel of respondents is already in place, the turnaround time can be cut in half. Three key factors affecting turnaround time are: ensuring soldier access to the Internet (officers are most likely to have access), setting a narrow scope for the survey, and developing and pretesting the survey questions.

How It Works

For the successful demonstration of ✓ Fast Tracker for the Army Chief of Staff, ARI placed the 15-item survey on the web-site the same day respondents were notified by email that the survey was available for completion. Just 17 days later, the briefing package reporting the results was delivered.

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IN THIS ISSUE

From the Director

The role of hardware/software technology in personnel and training performance is complex. The amount and range of technologies available can be overwhelming. There is a technology for every need: often-competing technologies. We are getting better at developing solutions based upon the capabilities provided by new hardware/software technology. The R&D objective is to use the "right technology" to improve soldier performance. However, the core issue for personnel and training R&D remain unchanged: improving soldier performance within a total performance context. This issue of the ARI Newsletter showcases different approaches used to meet this objective. We lead with an article on the leverage the Internet provides for dramatic increases in the efficiency and timeliness of personnel surveys. We next examine whether distance learning provides equivalent training value with resident training. The use and advantages of virtual reality are considered in an article on training small unit leaders and in an article on training distributed teams. Cognitive or thinking skills are the focus of two articles on critical thinking skills and the article on tacit knowledge. Advances in hardware/software technology were necessary, but not sufficient for research reported in each of these articles. The key sufficient ingredient is people, the human dimension. Hardware/software technology provides the potential for improved performance, but soldiers are required to achieve this potential.

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Note: Numbers that begin with "617" are Commercial (Area Code 703). Use "767 prefix for DSN (Defense Switched Network).

Web-Based Surveys

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Cost

Surveys using ✓ Fast Tracker are conducted by ARI on a cost-reimbursable basis for about $25,000. In addition to web-site maintenance and software upgrades, the costs for a ✓ Fast Tracker survey include printing, postage (for creating survey panels), processing email replies about membership on a panel, and survey statistician time for developing and pretesting the survey, analyzing the data, and reporting the results.

Assistance From ARI

In developing ✓ Fast Tracker surveys, ARI follows the standard practices for paper/pencil surveys. These practices include determining the specific purposes/goals of the survey; targeting what information is needed; considering alternatives to using a survey to collect the required information; determining the appropriate scope or size of the data collection effort; drawing scientific samples from the population being studied; matching question wording to the concepts being measured and the population being studied; selecting the appropriate format for displaying the questions and response categories; pretesting; protecting the privacy of individuals; using acceptable techniques to maximize the response rate; and using appropriate statistical analytic and reporting methods.

In addition, ARI provides respondents with the same level of control as paper/pencil surveys. For example, the respondent can see the entire question stem and range of responses, rather than scrolling up or down or from one side of the screen to the other. Additional, explanatory information or graphics may be presented if such information does not result in biasing the responses. ARI also ensures that mechanisms for protecting respondent privacy and ensuring anonymity are maintained in the system used for distributing the survey and collecting the completed responses.

Although longer web-based surveys can be conducted on several topics, more research is needed on the impact of long surveys on respondent cooperation and the quality of data collected.

Refined Capabilities

ARI has been refining its automated survey capabilities since it first fielded the automated Command Climate Survey for company-size field units in 1998 - http://www.ari.army.mil >> "Surveys."

By leveraging existing technology, ARI has produced a total package for conducting scientifically sound surveys, using the Internet.

✓ Fast Tracker provides controlled access by only those selected in the sample, user-friendly question and response category formatting, and protection of respondent privacy.

The Army Personnel Survey Office (APSO) at ARI has been working with Raosoft, Inc. of Seattle to refine a data collection software program that meets the Army's needs.

✓ Fast Tracker surveys are fielded through The Army Portal, a key component of Army Knowledge Online (AKO), maintained by the Army's Strategic and Advanced Computing Center.

For More Information

For more information on Army ✓ Fast Tracker, contact:

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Distance Learning and Battle Staff Performance

Job performance results demonstrate equal effectiveness for resident and distance learning groups

Distance learning (DL) can be defined as structured learning that takes place without the physical presence of the instructor. In recent years, such instructional formats have become increasingly popular and their use has accelerated. For example, in higher education this past year, more than 50,000 DL courses were taught to more than 7 million students. DL is the centerpiece of the Army University Access Online initiative, which provides soldiers with laptop computers to earn college and technical degrees online while serving on active duty.

The Army is seeking ways to increase education and training opportunities for all soldiers, improving the quality of instruction, increasing access to training, and reducing the time soldiers spend away from their unit. The Training and Doctrine Command (TRADOC) is transforming approximately 525 training courses to a DL format as part of a strategy to deliver training anytime anywhere. This future reliance on DL makes it important to evaluate the method's immediate and long-term effectiveness.

A battle staff NCO in action

The U.S. Army Sergeants Major Academy (USASMA) was concerned about the long-term effectiveness of its current DL programs. In terms of test scores and completion rates, the Academy had evidence of comparable results between courses taught either in residence or through DL. What remained uncertain, however, was how well students trained through distance learning performed *on the job* months after the training. The USASMA requested a study on the issue. The requirement stated:

"As USASMA continues to rely on DL techniques to design and develop courses, we must be certain the methods we choose are effective. We are sacrificing a tried and true method that works."

The U.S. Army Research Institute was tasked to perform the study, partly in house and partly under contract to Personnel Decisions Research Institutes, Inc. The study concentrated on the Battle Staff NCO Course (BSNCOC), the most mature of the Academy's DL courses.

Earlier research on distance learning, conducted mainly in civilian education settings, relied largely on student attitudes or end-of-course test scores as criteria for effectiveness.[1] Results of these studies vary, but in general the satisfaction with training among DL students tends to be somewhat lower than the satisfaction associated with face-to-face classroom training. Regarding learning outcomes, most studies have found that distance-learning students perform as well or sometimes better than their residence course counterparts on end-of-course tests.

The question central to this study involves the subsequent job performance of soldiers. Does DL, in comparison to residence training, result in similar levels of job performance? Clearly, the effectiveness of training targeted to impart specific job skills is best evaluated by assessing relevant job performance months later. The present study was designed to evaluate the BSNCOC in just this way.

The Course

The BSNCOC course is 32 days in length. The typical soldier is a Staff Sergeant or Sergeant First Class with 14 years of military experience. The first eight day's worth of material are delivered through CD-ROM, or in some cases in the classroom. The remaining 24 days

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1 ARI Technical Report 1095 "Training through distance learning: An assessment of research findings"

Distance Learning and Battle Staff Performance

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are taught either in residence at USASMA or through a DL format: two-way video, two-way audio connection originating from USASMA to remote sites at Forts Benning, Bragg, Hood, Polk, and Sill, and sites in Germany and Bosnia. The content of the residence and DL versions of the course are identical, as are the standards for successful completion.

Key Battle Staff Tasks

Working with instructors from the course, researchers identified eight key task dimensions and two measures indicative of successful job performance. The first measure was a knowledge retention test based on the training conducted on the eight key tasks. The concept was to measure the extent of knowledge decay with the rationale that the relative loss of knowledge would be slightly greater if a certain training method were less effective. A "normal" decline of about 15 percent was predicted, based on many previous research efforts.[2] The test was designed to be demanding; based on an analysis of 72 pilot items, 42 were selected for the knowledge retention test.

The second, more direct measure was supervisory assessment ratings. Here, immediate supervisors rated the soldier on the same eight task dimensions through a behaviorally-anchored rating scale. The descriptions included in the scale provide observable behaviors for the raters to recognize in assigning a rating from 1 (not effective) to 7 (highly effective). For example, in the assists in the military decision-making process (MDMP) task, "reluctantly participates in this process" would contribute to a lower rating, "effectively responds to requests for information regarding the MDMP" would contribute to a medium rating, and "proactively participates and contributes to this process" would contribute to a higher rating.

To aid in administering the rating scales to supervisors, researchers prepared a nine-minute videotape introducing the study and training raters to avoid various rating errors, such as a halo effect. Included was a video clip of the SMA encouraging participation.

Study Participants

NCOs who attended either version of the BSNCO course were evaluated from 6 to 16 months after graduation for their job performance on the eight task dimensions. The two groups' job performance levels were then compared to determine the relative effectiveness of the two versions of training delivery.

Performance data were gathered directly at three installations and indirectly at 11 sites through the mail. The residence group consisted of 92 graduates who took the knowledge retention test and 80 who were rated by their supervisor. The numbers for the DL group were 57 graduates with retention test scores and 47 with supervisory ratings. All members of the sample were Active Army and had graduated from the BSNCO course 6 to 16 months before the job performance measures were administered. The groups matched on demographic factors, such as age, field experience, and so on

Results

The retention test results for residence and DL groups were almost identical. The residence group had an overall average of 61 percent correct and the DL group 62 percent. A control group that took the same test immediately after the course scored only 73 percent, reflecting the test's difficulty. Thus, the knowledge retention was the same for soldiers trained through either method, and the relative loss

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2 ARI Special Report 39 "Staying sharp: The retention of military knowledge and skills"

Distance Learning and Battle Staff Performance

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of knowledge was within expectations for the normal decline after formal instruction. Based on knowledge retention, the DL group performed as well as the residence group.

Job Performance Ratings

The ratings averaged across all eight task areas were virtually the same at 5.1 on the seven-point rating scale. No significant differences between delivery methods emerged for any of the task areas. A complete table of ratings is provided below:

Supervisory Ratings by Task Dimension

(Rank ordered; 7-point scale)

Task Dimension	Residence	DL
Recordkeeping	5.6	5.9
Graphics/Overlays	5.5	5.4
Military Briefings	5.3	5.3
Combat Orders	5.2	5.0
Planning	5.1	4.9
Combat Support/CSS	4.9	5.1
Military Decision Making Process	4.8	4.9
Intelligent Preparation of Battlefield	4.5	4.6
Overall	**5.1**	**5.1**

Course Satisfaction

The USASMA study request also asked for measures of course satisfaction. For a sample of students (n=279) completing the course either in residence or through DL between September 1999 and April 2000, a questionnaire was administered to measure student perceptions of and satisfaction with the course. Also, course performance data for each student, in the form of test scores, were obtained from USASMA.

In general, students in the DL mode were not as satisfied with the BSNCOC as were their residence counterparts (avg. = 3.4 vs. avg. 4.1 on a five-point scale, statistically significant, $p < .01$). One factor that partially accounts for this difference is the perceived degree of interactions between students and the instructor. Compared to the residence students, the DL students reported having fewer interactions with the instructor. These findings are consistent with other DL studies that demonstrate level of interaction is a predictor of course satisfaction. Regarding preferences for their battle staff training, students in the DL course reported a preference for the residence mode. Correspondingly, students in the residence course reported a preference to stay with the residence mode.

Conclusions

This study was designed to evaluate the relative effectiveness of the residence and distance learning versions of the BSNCO course with respect to subsequent actual job performance. Statistical analyses indicated virtually no between-group differences on either performance measure; retention of course knowledge and rated job performance on key task areas were almost exactly the same.

The findings of this study suggest that DL graduates' immediate learning, knowledge retention, and performance on the job are equally effective compared to residence course graduates. This holds despite the fact that students were not as satisfied with the DL course and would have preferred the residence mode of instruction. How to achieve similar levels of satisfaction for DL and residence modes is an interesting question. Results have implications for the planned conversion of many residence courses to a DL format. The evidence reported here supports the short and long-term training equivalency of this delivery method for the type of tasks prevalent in preparing battle staff NCOs for the job.

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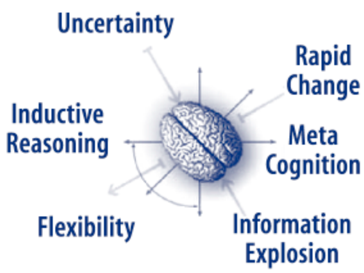
Training Critical Thinking Skills for Battle Command: How to Think, Not What to Think

Improve critical thinking to improve battle command tactical performance

Interest in training critical thinking (CT) skills has increased over the past 20 years in a variety of settings such as high school, higher education, corporations, government service, and nursing. Critical thinking skills are becoming especially important now as our world is changing at an ever-accelerating rate. Change is the status quo, not the exception.



Critical thinking skills (CTS) are also becoming recognized as more important to the Army as it looks to the uncertainties of future operations. Unimagined missions with no clear-cut school solutions will be executed. Army operations have become digitized and the capabilities of this digitization keep changing. Technology has created an information explosion. CTS are needed to adapt to a changing environment's complexity, uncertainty, ambiguity, and information overload.

Army officers already have good sets of knowledge and skills, but providing explicit direction in how to think or reason can broaden and deepen those skills and have a multiplier effect on performance. Traditional training does not provide explicit direction in how to reason or think.

What is Critical Thinking?

Critical thinking skills have been a topic of research and training in the education community for over fifty years. Despite this, theories and research on CT are highly fragmented and there is no agreed upon definition of what CTS are, how to train them, or how to measure them.

One researcher, Dr. Diane Halpern, defines CT as the use of cognitive skills or strategies that increase the probability of a desirable outcome. It is purposeful, reasoned and goal directed. It involves evaluating the outcomes of our thought processes (e.g., how good a decision is), and evaluating the reasoning that went into a conclusion. There are two aspects to CT: (1) the basic skills and abilities to think critically and (2) the disposition or willingness to use those abilities. Both are needed. Some people may have the ability to think critically, but may not be willing to put forth the effort needed to do so. On the other hand, one may want to engage in critical thinking, but not have the required skills to do so.

There has been much debate about what counts as "critical thinking". Hundreds of CTS have been cited in the literature of education, philosophy and psychology and many ways of categorizing the skills have been proposed. Some examples of CTS are listed in the box below.

Examples of Critical Thinking Skills

- Questioning assumptions
- Framing a problem
- Inductive reasoning
- Deductive reasoning
- Mentally simulating plans
- Avoiding reasoning fallacies
- Meta-cognition
- Extracting meaning from information
- Adopting multiple perspectives

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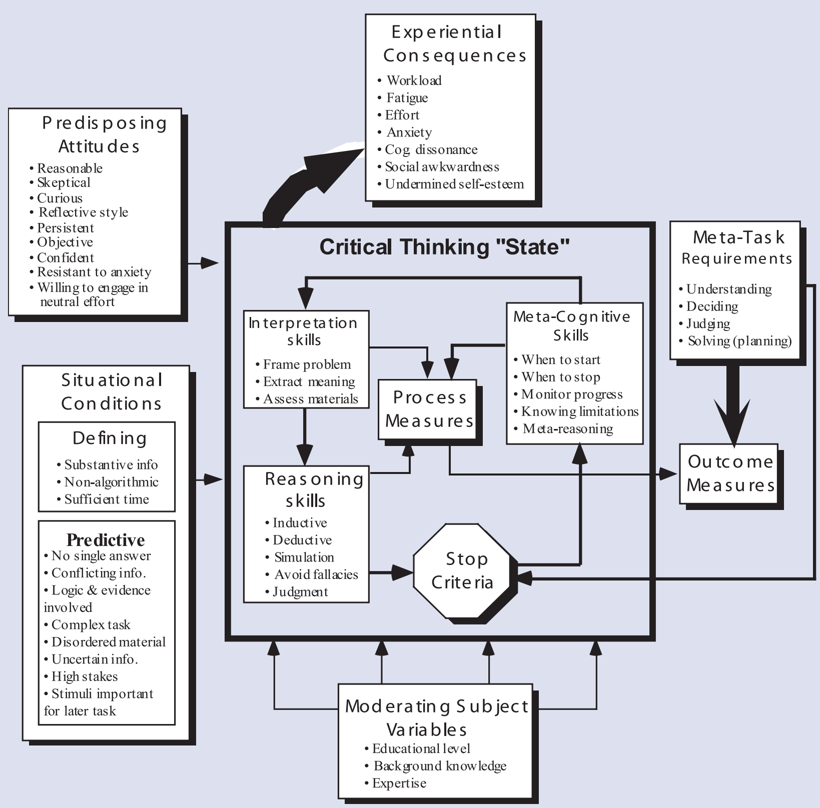
A Framework for Thinking about Critical Thinking

Critical thinking is a complex process. The diagram below shows a model that organizes the many factors that affect an individual's critical thinking processes.

Opportunities for CT arise when *situational conditions* make it desirable for a person to engage in CT. These conditions relate to the task or environment. People have *predisposing attitudes* that make it more or less likely that they will engage in CT, for example skepticism. *Experiential Consequences* are emotional reactions a person may experience while engaging in CT, which may affect his willingness to continue. *Moderating variables*, such as expertise, may affect both the quality of CT and the propensity to engage in CT. *Meta-tasks* serve to define the general purpose of the CT activity. The *Critical Thinking State* shows three categories of skills and processes that are involved when an individual engages in CT. *Meta-cognitive* skills are those we use to monitor our own thinking. Meta-cognition is stepping back and observing ourselves - observing what we know and what we don't know, observing and judging the quality of our thinking, and making decisions about how to use our time and effort. The skills listed in the diagram are not exhaustive, but are only examples.

A Framework for Thinking About Critical Thinking



Research on Training Critical Thinking Skills

If CTS are to be trained, we need to know the answers to basic questions such as: Are CTS trainable? What methods are most effective in training CTS? Does training in one area generalize to CTS in other content areas? What are effective methods for promoting the generalizing of CTS from one area to another? Do different CTS require different training approaches? Can critical thinking dispositions be trained? How can CTS be measured? How should training be assessed?

Research in education and psychology has not answered these questions conclusively. However, the findings are encouraging. There is research evidence that adults can be taught to improve their CT skills, although this conclusion varies with the specific skill. The results of one ARI sponsored study are shown below. The study compared a group of Army officers who received training in CT with a group which did not receive the training. An evaluation of the training showed that training in CT improved tactical planning performance.

A significantly higher proportion of participants trained in CT vs. untrained participants:

- Correctly restrained from over commitment of forces.

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- Included sound tactical plan elements
- Detected problems with assumptions and goals
- Used a proactive time orientation
- Performed contingency planning
- Appropriately used ground forces

There is evidence that training can change dispositions to think critically. In fact, attitudes or dispositions are regarded by some as the most effective level for training. Training CT attitudes may involve more profound change in the person than teaching a new strategy.

One of the reasons for training CT in the Army is the emergence of novel and uncertain missions. It is important, then, that CTS be taught so that they will transfer to novel situations. Training techniques have been developed that encourage the transfer of CTS to new areas.

ARI is engaged in a number of projects to address research questions like the ones cited above and to develop training in critical thinking for Army officers. Three of these projects are described next.

ARI Projects in Critical Thinking Training

Training CD: Training to Think Critically on the Battlefield

ARI sponsored the development and evaluation of a training system for CTS that supports procedures in the Military Decision Making Process. The training system was developed by Cognitive Technologies, Inc. It was used and evaluated at the Army Command and General Staff College.

This training aims to improve the ability of Army tactical staff officers to quickly grasp the essential elements of a complex, uncertain, and dynamic situation, visualize those elements in terms of their units' goals, and take action in a timely and decisive manner.

To accomplish these aims, four CTS were chosen for training. The first skill is keeping the goal of the mission upper most in mind and having it drive all aspects of planning. The second skill is time orientation - knowing when and how to be proactive, predictive, and reactive in planning and how to turn predictive courses of action into proactive courses of action, or reactive into predictive courses of action. The third skill is identifying problems in your mental model of the situation and then correcting them. Problems to look for include unreliable assumptions, missing information, and conflicts between information sources, tasks, or purposes. The fourth skill involves challenging your plan to see how and why it might fail even if you are certain it will succeed, and then changing the plan to deal with unaccounted for factors.

The training system includes structured instruction, historical examples, guided practice using practical scenarios, detailed feedback, and performance measures. It is accessible either through the CD-ROM, available from ARI, or over the World Wide Web. The training is suitable for classroom instruction, training in the field, or distance learning. Reports documenting this work are available.

Workshop on Critical Thinking for Battle Command.

In December 2000, an invitational Workshop on Critical Thinking Skills for Battle Command was held at Fort Leavenworth. Participants included experts in academic research and Army officers in fields related to training CTS.

Presenters at the Workshop provided an overview of current research in CT, adult

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learning, and CT training and extended discussions provided a forum for identifying and discussing issues related to training CT in the Army. Participants developed recommendations for training CT in the Army and directions for future Research and Development.

Preliminary recommendations from the Workshop include the development of valid evaluation methods and measures of CT. Historically, measurement of CT has been problematic. However, without valid evaluations, we can't know if the training is effective. Participants also recommended an examination of the Army cultural context for critical thinking. If the culture doesn't support the use of CTS, they won't be used not matter how effective the training.

A Special ARI Report will be published in September 2001, which will contain Workshop presentations and describe the discussion recommendations.

Web-Based Training for Critical Thinking Skills
As a preliminary step to developing web-based CT training, this project reviewed the concepts and research on critical thinking in fields of philosophy, education and psychology. From this review the model of CT described earlier was developed. Based on a survey of Army officers that focused on situations and conditions on the battlefield, 13 key thinking skills important for successful performance were identified. A report documenting the literature review and CT model is available. This training is expected to be completed in 2002.

Conclusion

Under current training programs, most officers are left to somehow develop their critical thinking skills on their own. Training of theses skills is an implicit by-product of formal education, training exercises and self-development. Explicit training in critical thinking holds great promise to give Army officers added skills in dealing with the uncertainties of the 21st century.

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Training and Assessment of Decision-Making Skills in Virtual Environments

Preparing small unit leaders (platoon, squad, and team) for future warfare presents many challenges to trainers. Leaders must be capable of taking effective independent actions across an increasingly diverse range of military missions including humanitarian assistance, peacekeeping, and low or high intensity conflict.

Many missions will take place in urban settings. Conducting the requisite training at existing real world urban training sites can be very expensive and inefficient in terms of the specific leader skills needed for such operations. The small unit leader operating in an urban environment has a cognitively challenging job.

Components of Training Effective Decision-Making Skills

Critical to unit success is the leader's ability to recognize environmental cues and relevant situational factors, maintain situational awareness (SA), apply appropriate strategies, and make effective real-time decisions. Adequate preparation for such missions would require exposing the soldier to multiple scenarios, providing sufficient practice, and timely feedback, so he can effectively assimilate the many lessons learned.

Clearly, following such an approach in the real world would be very costly. One solution is to conduct a portion of this training in virtual environments through the use of individual combatant simulators.

Using Virtual Environments to Train Decision-Making Skills

A virtual environment, which can be used for training and education, is taking shape at the Land Warrior Test Bed (LWTB) at Fort Benning, Georgia. Here, an individual soldier or small unit leader can explore innovative approaches for conducting urban operations and mission rehearsal activities in virtual settings. Through the use of individual combatant simulators (Figure 1), soldiers can immerse themselves in virtual representations (data bases) of urban training sites and conduct limited missions (e.g., clear a building). Virtual environments offer soldiers the opportunity to rehearse missions to familiarize themselves with the procedural aspects of specific tasks as well as offering a chance to examine new tactics and techniques. These simulators allow the soldiers to play out scenarios and determine the impact of various courses of action on the likely success of a mission.

Figure 1. LWTB individual combatant simulator system.

Using Virtual Environments for Decision-Making/Situational Awareness Research and Training

Research. The LWTB provides an ideal setting for the development of SA measurement instruments that can be used by trainers and researchers in simulation and field environments. The virtual environment allows for greater control of both extraneous and experimental variables than is possible in a real world training site. Under the controlled setting of the LWTB, new SA measurement instruments tailored specifically for dismounted infantry operations can be examined and refined. This type of setting also provides, for the first time, a unique opportunity to conduct basic and applied research linking SA to deci-

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This research showed a linkage between decision-making and situation awareness

Training and Assessment of Decision-Making Skills in Virtual Environments

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sion-making in simulated dismounted infantry environments.

Training. Simulations can play a key role in training decision-making skills and possibly refining individual SA capabilities as well. Simulations accelerate proficiency by exposing the small unit leader to the kinds of situations he is likely to confront in the real world. More importantly, a simulation can be controlled. The characteristics of the decision problem portrayed in a mission scenario can be shaped to address specific teaching points based on trainer input. Time constraints, specific situational cues and cue patterns from various sources (e.g., audio communications, civilian/enemy presence) can be incorporated in the scenarios.

Increasing exposure to varied scenarios, combined with structured feedback, should enhance the leader's ability to accurately characterize situations and lead to greater situational understanding. This, in turn, should lead to improved decision-making capability.

Research Objectives

ARI was able to leverage the many positive features offered by the LWTB under a single comprehensive research effort having both basic and applied objectives. The primary objectives were to:

1. Determine the effectiveness of using a virtual environment to train real world decision-making skills.

2. Determine the feasibility of using a virtual environment as a test bed for developing SA measurement instruments.

3. Empirically assess the role of SA in decision-making in simulated dismounted infantry environments.

Design Overview

Experienced (captains) and inexperienced (second lieutenants) officers were put in an immersive virtual environment (using the LWTB's individual combatant simulator systems) and given four scenarios to execute. Scenarios included built-in decision points that required the officer to take specific actions at each point.

Each officer played the role of an infantry platoon leader and conducted four virtual urban missions. Confederates played the roles of the company commander, platoon sergeant, and squad leaders. Computer generated forces were used to fill squad/team member positions.

An observer/controller offered guidance during the scenario, provided feedback following the completion of each scenario, and assessed the officer's leader/decision-making capability and level of situation awareness. During the actual mission, objective decision point and SA data were obtained. After each mission, officers and role players completed paper-and-pencil instruments addressing leader/decision-making skills and additional SA knowledge areas.

Major Findings

"I was forced to make quick and accurate decisions…very realistic."

"This will give leaders the opportunity to learn and develop without jerking soldiers around. Platoon leaders would [arrive at their new units] more informed and…confident".

Objective assessment of decision-making skills. Errors for each decision-point were recorded and summed for each scenario (trial). A percentage was calculated based on the total number of possible decision-making errors for a given trial.

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Training and Assessment of Decision-Making Skills in Virtual Environments

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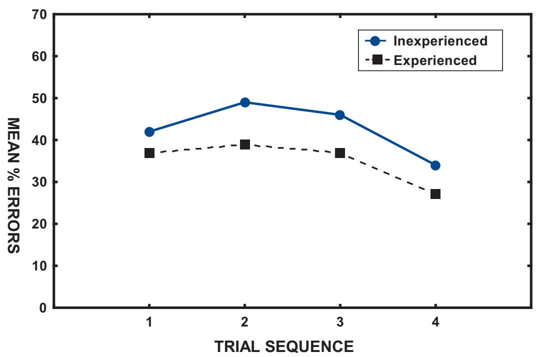
Decision- making errors (failure to act) increased from Trials 1 to 2 and then decreased over the remaining trials (Figure 2).

Figure 2. Mean percentage of decision-making errors over trials by group.



Overall, there was a tendency for the experienced group to make fewer errors over trials than the less experienced group. A comparison of error rates shows that signficantly fewer decision errors were made in Trial 4 than in Trial 1.

Situation awareness ratings. Ratings from SA instruments yielded different patterns of results. The most noteworthy findings centered around experience levels and objective items asking the subjects to identify elements on a map (Figure 3). Experienced officers more accurately located friendly/enemy elements on the map. They also showed better SA for threat situations (identifying strongest enemy locations and the element posing the highest threat to their platoon). Conversely, inexperienced officers showed better SA for friendly strength (identifying the locations of the strongest friendly elements).

Predicting decision-making accuracy from SA measures. Additional analyses were performed to determine the set of SA items/factors that best predicted decision-making accuracy. The following factors/items predicted 69% of the variance in decision-making scores. The model is shown below.

Decision Score = Focused Inside the Platoon + Self Rating + Objective SA Items

Focused Inside the Platoon

- Communicates key information to commanding officer
- Gathers follow-up information when needed
- Asks for pertinent intelligence information
- Assesses key finds and unusual events
- Discerns key information from reports received

Self-Rating

- Workload

Objective SA Items

- Locations of friendly units exposed to enemy fire/attack
- Which side has the advantage
- Which friendly elements have lost communication

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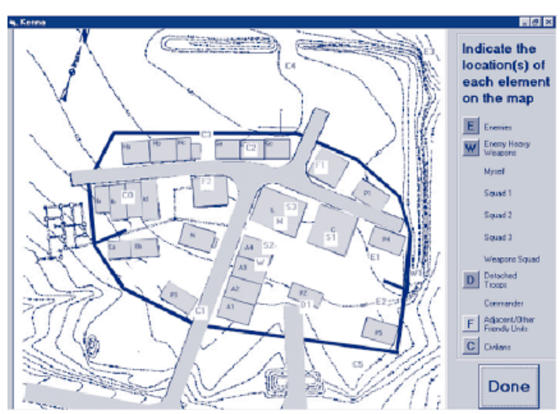

Figure 3. Example of map used to objectively assess SA knowledge.

Training and Assessment of Decision-Making Skills in Virtual Environments

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Conclusions

Overall, the immersive environment created by the individual combatant simulation systems provided the opportunity to simulate conditions similar to what the soldier might experience in the real world (i.e., fluid, dynamic environments requiring quick, rapid decisions). Soldiers were clearly challenged and could both see and hear the consequences of their actions unfold in real time and in subsequent message traffic received from the squad leaders, platoon sergeant, and the company commander. More importantly, this can all be accomplished in a safe training environment where soldiers can profit by learning from poor decisions made in earlier scenarios.

The research showed that a virtual environment can be used as a test bed. Valuable insights were obtained showing the possible complimentary aspects of the different SA measures and how the focus of SA changes with experience. Additionally, conducting research in the controlled setting of the LWTB permitted closer empirical examination of the linkage between decision-making and situation awareness for dismounted infantry.

Items from the SA measures contributed significantly to the prediction of decision-making accuracy. Many are concerned with an individual's ability to assess the importance of various pieces of information from much larger pools of information, such as discerning critical cues. These activities form the cornerstone of the training approach used in this research. While we have only begun to tap the capabilities of this technology, the overall pattern of results indicates that virtual immersive environments offer a potential cost effective means for conducting real world decision-skills training.

For additional information, contact Dr. Robert Pleban, Infantry Forces Research Unit, DSN 835-3617/Commercial (706) 545-3617.

"Did you know that…"

Soldiers at Work

54.2% of all officers and 40.8% of enlisted personnel (PV2-CSM) reported they work 12 or more hours on a "typical/average duty day" (including all activities required for duty, i.e., PT, etc.)?

87.8% of all officers and 88.5% of enlisted personnel (PV2-CSM) reported they usually do their "daily Army work with the company (or other similar unit)" to which they are assigned?

84.4% of all officers and 81.1% of enlisted personnel (PV2-CSM) reported they are currently working in either their "primary or secondary branch/MOS"?

19.8% of all officers and 36.8% of enlisted personnel (PV2-CSM) reported they have been away from their duty station for "military duties (including deployments, assignments, training, TDY)" for less than 1 week during the last 12 months?

21.1% of all officers and 15.7% of enlisted personnel (PV2-CSM) reported they have been away from their duty station for "military duties (including deployments, assignments, training, TDY)" for 1-4 weeks during the last 12 months?

24.3% of all officers and 23.2% of enlisted personnel (PV2-CSM) reported they have been away from their duty station for "military duties (including deployments, assignments, training, TDY)" for 13 or more weeks during the last 12 months?

Tacit Knowledge for Military Leadership

Tacit knowledge scores, a better predictor of leadership effectiveness

Development of Military Leaders

Army leadership doctrine clearly acknowledges the importance of leader knowledge. The Army has an integrated, progressive, and sequential program of leader knowledge development based on three pillars: 1) institutional training, 2) self development, and 3) operational assignments. It is widely acknowledged that the most important and effective of the three is operational assignments.

Army leaders learn about leadership while doing real work in the motor pool, in the field, and in the barracks. But this research is the first systematic effort to understand this practical, experience-based knowledge and its relevance to leadership effectiveness. On-the-job experiences provide opportunities for officers to learn how to apply leadership knowledge codified in doctrine and taught in the Army school system, and they provide a context for acquiring new knowledge about leadership knowledge not well supported by doctrine or formal training (we call this "tacit knowledge"). Because leaders acquire much of their knowledge from operational assignments, understanding what it is that they learn and how to promote successful learning is the objective of this research.

The tacit knowledge approach to understanding leadership looks at knowledge that is experience-based, practically-relevant, and acquired with little support from the environment (e.g., through formal instruction and coaching). A multi-year study was conducted to apply the tacit-knowledge methodology to understanding what distinguishes more from less effective leaders. The methodology and results of this long-term effort are summarized below.

Tacit Knowledge for Military Leadership

The tacit knowledge for military leadership project is aimed at understanding the role of operational assignments in the development of effective leaders. The plan is to use this knowledge to speed up leadership development through web-based instruction and self-development. We developed and validated tacit knowledge inventories for leaders at three echelons: platoon leader, company commander, and battalion commander.

We first interviewed 81 Colonels and LTCs and gathered stories and advice about their lessons learned about leadership. These stories were then simplified into coded tacit-knowledge items and administered in the form of a survey to over 1,500 officers who rated the quality of each knowledge item. The quality ratings and content categories were used to select the most promising items for developing an inventory to measure tacit knowledge. For those items that were retained, a more detailed problem scenario was developed using the original interview data. Each scenario posed a leadership problem along with a set of 5 to 15 possible responses. These scenarios have now been rated by hundreds of officers at ranks from LT to LTC. A sample scenario is shown in Figure 1 (see next page).

Results

We found that tacit knowledge for military leaders (TKML) scores generally were a better predictor of leadership effectiveness than verbal ability, rank, or experience. Experience, as measured by months in a job, showed no relationship with leadership effectiveness. Verbal ability correlated moderately with leadership effectiveness at the platoon and company levels. But tacit knowledge consistently predicted effectiveness above and beyond verbal ability at all echelons. Our research indicates that tacit knowledge adds to our understanding of leadership effectiveness, and does so beyond traditional predictors that have had more limited success.

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Tacit Knowledge for Military Leadership

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Practical Intelligence and Learning Tacit Knowledge

Implicit in our work on the identification and measurement of tacit knowledge is the notion that some individuals are better than others at learning from their experiences. Sternberg has called this underlying ability "practical intelligence". Practical intelligence proposes that success in any domain involves recognizing one's strengths and applying them in the pursuit of personally valued goals. Practical intelligence is the ability to adapt to, select, and shape environments in the pursuit of personally valued goals. To adapt is to change oneself to suit an existing environment; to shape is to change an existing environment to suit oneself; and to select is to find a more suitable environment than the current one. Measures of tacit knowledge can assess any or all three of these aspects of practical intelligence. For example, tacit knowledge for management may address primarily one's ability to adapt to environments, while tacit knowledge for leadership may measure the ability to shape environments.

Tacit knowledge represents an aspect of practical intelligence – it is knowledge gained in the process of solving practical problems. It represents the ability to learn from performing poorly-defined, context-specific practical tasks that do not necessarily have clear answers.

The Development of Expertise

Literature on the development of expertise provides some direction for exploring how tacit knowledge is learned. Research on famous musical composition shows that it is dependent on extensive experience, knowledge and practice, with most composers of genius (such as Mozart) requiring at least ten years of effort before they produced work of sufficient quality to be recorded. This suggests that leadership expertise is learned at a similar slow rate as officers rise in rank. TKML results (see Figure 2) bear this out.

Tacit knowledge scores increased steadily across all three echelons (Platoon, Co, and Bn) on all three instruments. We would expect that rank would have the least affect on scores at the platoon level where all officers, even lieutenants, have had extensive experience as platoon leaders. Therefore, we should find the smallest differences in TKML scores and experience across ranks at this level. On the

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Figure 1. Sample question from the Tacit Knowledge Inventory for Military Leaders. For sample answers, see http://www.companycommand.com/tacit2/index.html

1	2	3	4	5	6	7	8	9
Extremely Bad		Somewhat Bad		Neither Bad Nor Good		Somewhat Good		Extremely Good

Sample. You are a company commander, and your battalion commander is the type of person who seems always to "shoot the messenger"– he does not like to be surprised by bad news, and he tends to take his anger out on the person who brought him the bad news. You want to build a positive, professional relationship with your battalion commander. What should you do?

___ Speak to your battalion commander about his behavior and share your perception of it.

___ Attempt to keep the battalion commander "over-informed" by telling him what is occurring in your unit on a regular basis (e.g., daily or every other day).

___ Speak to the sergeant major and see if she/he is willing to try to influence the battalion commander.

___ Keep the battalion commander informed only on important issues, but don't bring up issues you don't have to discuss with him.

___ When you bring a problem to your battalion commander, bring a solution at the same time.

___ Disregard the battalion commander's behavior: Continue to bring him news as you normally would.

___ Tell your battalion commander all of the good news you can, but try to shield him from hearing the bad news.

___ Tell the battalion commander as little as possible; deal with problems on your own if at all possible.

Tacit Knowledge for Military Leadership

Continued from previous page

company and battalion instruments, we expect rank differences to be more apparent since only senior officers in the sample have had experience at these levels. This expectation is confirmed by the greater rise in scores from LT to LTC, and significant correlations involving rank on both the Co TKML and Bn TKML (r = .44 and .41 respectively).

Knowledge or Art

Although the survey questions provide amazingly accurate and replicable measures of tacit knowledge, they do not answer the age old questions of how much of leadership is science, and how much is art; how much is learned and how much is inborn. What we now know is that we have a powerful new instrument to assess non - doctrinal leadership knowledge and reasoning. A little bit more of the mystery of leadership has been exposed with a new technology that appears to have the potential of creating objective measures of very complex intuitions and expert insight. By converting intuition and insight into knowledge, we have raised the real possibility that this is trainable. If this proves true, we will be able to construct an interactive web-based environment that may be used for instruction or self - development in tacit knowledge to improve leadership in the Army.

Echelon	LT	CPT	MAJ	LTC
Platoon TKML	.64	.69	.68	.71
Co TKML	.62	.66	.70	.71
Bn TKML	.60	.68	.69	.76

Figure 2. Sample scores on the Tacit Knowledge inventory for Military Leaders at Platoon, Co, and Bn levels, showing increasing scores by rank from LT to LTC.

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Sternberg, R.J., Forsythe, G.B., Hedlund, J., Horvath, J. A., Tremble, T., Snook, S., Williams, W.M., Wagner, R.K., & Grigorenko, E.L. (2000). *Tacit knowledge in the workplace.* Technical Report 1093). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

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Team Performance in Distributed Virtual Environments

Local team performance compared to geographically distributed teams

The U. S. Army has developed distributed simulation systems for combat training of its mechanized forces. There is currently no satisfactory system for representing dismounted combatants in these virtual simulations. The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) Simulator Systems Research Unit, supported by the University of Central Florida Institute for Simulation and Training (IST), has established a research program to improve the Army's capability to provide effective training for Dismounted Infantry through the use of Virtual Environment (VE) technology and Individual Combatant Simulation. The Canadian Defence and Civil Institute of Environmental Medicine (DCIEM) is also exploring these technologies with the goal of extending the benefits of virtual simulation to dismounted combatants. A collaborative research project was established under the auspices of The Technical Cooperation Program, Training Technology Technical Panel for ARI and DCIEM to investigate training geographically distributed teams using Virtual Environments.

VE Training & Distributed Teams

Current methods for training dismounted units are costly and personnel intensive. Training sites are expensive to build and instrument, and are not easily altered to present varied environmental challenges. VE systems will be able to provide effective and less costly alternatives for training dismounted soldiers. VE simulations allow multiple simulated environments, enabling training and rehearsal under a variety of conditions. VE simulations allow multiple players and computer-generated forces to mimic the behavior of troops, indigenous populations, and enemy forces.

VE also opens the door for an entirely new type of team training -- one in which individual team members are physically in different cities, states, or countries, but still train with one another as if they were in the same locale. While immersed in a virtual environment, the team members are able to see each other's representation, or AVATAR, in the VE and they can communicate through the use of microphones and headphones. But, during After Action Reviews (AARs) geographically distributed team members will not be able to communicate in the same way as teams trained in the same location. Because vital interpersonal interactions may be reduced in these situations, it is possible that teams trained via distributed simulation will experience a deficit in team performance.

To investigate the nature of this potential problem, the ARI/DCIEM team conducted an experiment to investigate whether teams whose members are trained in VE in the same physical location will perform differently than teams whose members are situated in remote locations (with more restricted non-exercise interactions). In order to be able to generalize

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Team Performance in Distributed Virtual Environments

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the findings, we used a generic framework for the team missions, with tasks and activities representing a range of individual and collective tasks. This framework was developed in an earlier team training research project. (See "Instructional Strategies for Team Training in Virtual Environments," *ARI Newsletter*, Vol. 10(1), Spring 2000.)

Mission Rehearsal in Distributed VE

The Fully Immersive Team Trainer (FITT) supports experimentation in the use of VE technology for small team activities. The system uses MotionStartm Sensors to track body position, support the head-tracked visual display, gesturing, aiming and firing weapons, operating equipment, and movement through the VE. The Virtual Research V8 helmet mounted display (HMD) provides the visual display. Headphones and microphones support simulated radio nets, allowing participants to communicate with each other and other personnel. System data capture allows playback of each mission, synchronized with digitized recordings of communications, and both time-based streamed data and processed summary information. Playback can be presented in real time; or manipulated for fast, slow, or stop-action motion.

Our synthetic mission requires teams to search a building, neutralize opposing forces, not harm noncombatants, and disarm canisters containing hazardous materials. The teams must move, shoot, and communicate in the restricted VE. The teams also coordinate individual activities to accomplish collective tasks. The most important of these is gas canister disarming. Canister disarming is a time-driven task that requires monitoring, communication, tool use (for disarming), and feedback between team members. Each participant is trained on all tasks before the team is formed and mission rehearsals begin.

Each team then performs eight missions with an after-action review (AAR) following each mission. Mission sessions are distributed over several days.

During this experiment, a minimally guided AAR was used to review the activities performed during each mission, and correct or improve performance. During the ten minute AAR, a segment of the completed mission was replayed. The team was provided with a written example of the correct protocol, and instructed to discuss *what* happened, *why* it happened that way, and *how* they could do better during the next mission.

In the local condition, team members communicated face-to-face with one another during the AAR. After completion of the AAR, team members also had time to speak with each other on non-mission topics. In the distributed condition, the team members communicated only by telephone during the AAR replay (played simultaneously at each location). Distributed team members did not have an opportunity for further discussion after the AAR.

Results

The overall outcome measure is the number of rooms successfully completed in a mission scenario (Good Room Searches). This was the number of rooms searched, with canisters correctly handled, opposing forces (OPFOR) neutralized, and non-combatants not harmed. This measure revealed significantly better performance by the local teams, as shown in Figure 1 (see next page).

The local teams also performed better than the distributed teams on the associated process measures, Room Search Time and Hallway Movement Time. All three of these measures addressed combinations of individual and

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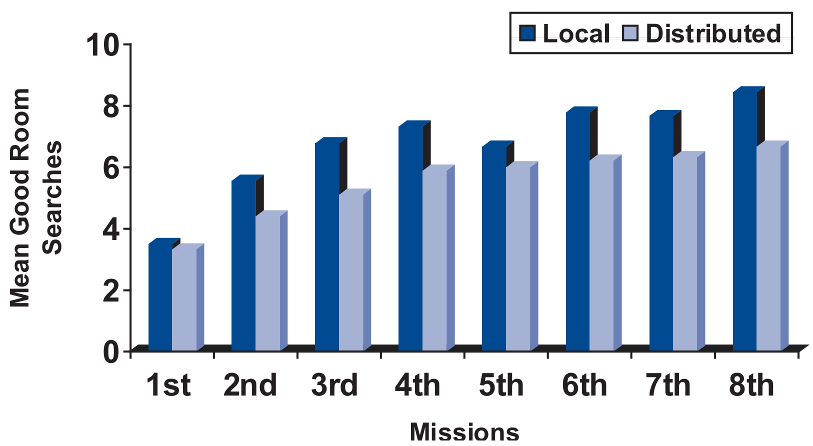
Team Performance in Distributed Virtual Environments

Figure 1. Mean Good Room Searches over Mission Rehearsals.



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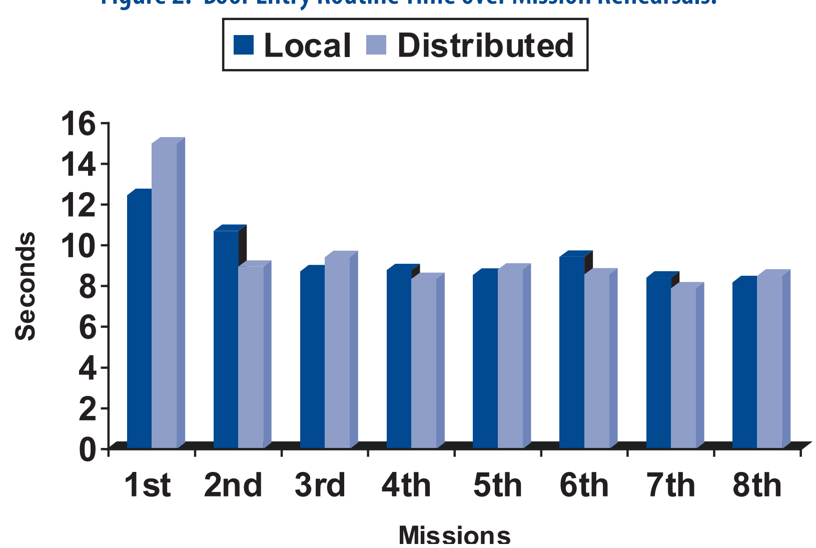
collective tasks, and seem to be good indicators of teamwork proficiency.

In contrast, more structured collective tasks did not show significant differences between the local and distributed teams. These measures were the average time to perform either Door Entry or Canister Disarming, as shown in Figures 2 & 3. Even though these tasks were complex and collective, they may have been easier for team members to monitor for performance problems and make corrections because they were more tightly linked to individual actions within the collective task.

Figure 2. Door Entry Routine Time over Mission Rehearsals.



In addition, the expected significant improvement over repeated missions was also found with all the measures, demonstrating learning over trials. This can be seen in all figures.

Based on previous research, we thought performance differences between local and distributed teams could result from differences in the way the team members communicated with each other. However, an analysis of communication patterns of team discussions during the AARs did not reveal differences between the local and distributed teams. We are conducting additional analyses of teamwork aspects of performance and communication to try to understand causes of the local vs. distributed performance differences.

There is clear evidence in our data that task performance improves over mission trials. However, we all know that practice on any task with attention and feedback will lead to improved performance. What is more interesting is that the significant difference between the local and distributed teams on the global outcome and process measures is consistent and doesn't diminish over repeated missions.

Discussion

The ability to train geographically distributed teams and units is a highly likely requirement for the widely distributed Objective Force. The central issue for trainers is ensuring that distributed teams will learn and improve in the same manner and amount as local teams. Our data shows significant differences in the more

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Team Performance in Distributed Virtual Environments

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global outcome and process measures, but no similar differences in the more tightly structured tasks.

This is the first experiment to look into these issues and it is at this point unclear what causes the differences in performance between the local and distributed teams. As mentioned above we are investigating factors that might cause this difference in data that has yet to be analyzed. Further research in the efficacy of distributed team training will probably be needed to clarify these issues.

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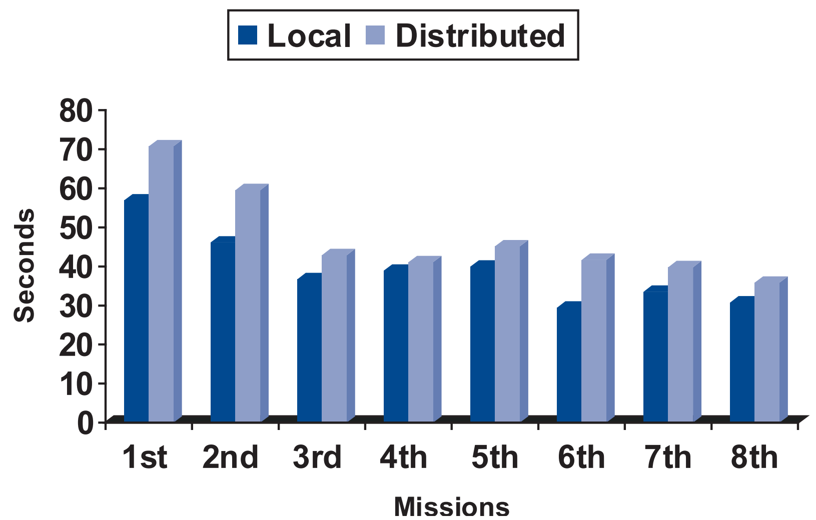
Figure 3. Mean Time for Canister Disarming Routine.



"Did you know that. . ."

Soldier Demographics

3.3% of all officers and 6.9% of enlisted personnel (PV2-CSM) consider themselves to be multiracial (i.e., selected two or more of the following official U.S. Census racial categories: American Indian or Alaskan Native, Asian, Black or African American, Native Hawaiian or other Pacific Islander, or White)?

6.1% of all officers and 15.8% of enlisted personnel (PV2-CSM) reported they are of "Hispanic, Latino or Spanish origin or ancestry (of any race)"?

Of those of Hispanic, Latino or Spanish origin or ancestry (multiple responses were accepted):

36.4% of officers and 42.8% of enlisted personnel reported they are Mexican, Mexican, Chicano?

30.1% of officers and 29.6% of enlisted personnel reported they are Puerto Rican?

29.8% of officers and 27.3% of enlisted personnel reported they are of other Hispanic/Spanish origin or ancestry?

7.8% of officers and 3.8% of enlisted personnel reported they are Cuban?

35.4% of all officers and 6.8% of enlisted personnel (PV2-CSM) reported they have completed a masters or higher level degree?

U.S.Army Occupational Analysis Program

Provide commanders with the best possible match of soldier to jobs

The U.S. Army's Occupational Data Analysis, Requirements, and Structure (ODARS) Program links Manpower, Personnel and Training (MPT) information at the Military Occupational Specialty (MOS) job level with individual task information critical to job design, analysis and training development.

Introduction

The ODARS program performs occupational analyses and job design throughout the Army to provide MPT communities with important information that ensures the availability of soldiers with appropriate skills to meet Army-wide requirements. The Occupational Analysis (OA) program supports Army Staff and various organizations throughout the Army, but in particular, it helps MPT communities provide field commanders with the best possible match of soldiers to jobs.

Background

The OA program was established in the late 1960s to help resolve MPT issues associated with the Army's role in Vietnam. During the Vietnam War the number of MOS peaked, and then began declining once the war ended. However, as new weapon systems were developed, soldier tasks and jobs changed. MOS for numerous jobs were altered or merged, and new MOS were formulated to meet dynamic changes in the Army.

Occupational Analysis and the Customer

OA projects are determined through a yearly solicitation of potential customers, primarily the specialty schools of the U.S. Army Training and Doctrine Command (TRADOC). Proponent schools determine MPT requirements at the MOS/job level, and then work closely with the OA staff to do MOS analysis and job redesign. Results of the process include: a) adjusting the MOS structure and tasks in response to procurement of new weapon systems, equipment, or complex materiel systems; b) merging two or more MOS to create new MOS or additional skill qualifiers; and/or c) substantive changes in Army operations and procedures as a result of new materiel systems entering the inventory. The OA program is currently involved with helping determine the MOS structure that will best support the Interim Brigade Combat Teams (IBCT).

Enlisted Common Soldier Tasks Example

Based on perceived deficiencies in the training and performance of Enlisted Common Soldier Tasks (ECST), the U.S. Army Sergeants Major Academy requested assistance in defining the ECST domain and developing recommended changes to the existing training for privates through sergeants first class. From a base of 153 documented ECST tasks, ARI isolated a total of 553 potentially common critical tasks through interviews of Non-Commissioned Officers (NCOs), focus groups, and the review of related literature. An automated survey of approximately 6700 soldiers in the Active and Reserve Components provided the data necessary to quantify the probability that a task was performed at a given enlisted skill level as well as an estimate of the frequency with which that task was done each year. A critical task selection board reviewed the task

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U.S.Army Occupational Analysis Program

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lists and supporting data. Over 300 tasks were identified as critical ECST tasks. As a result, these tasks are being incorporated into Army common core training from Basic Combat Training through Advanced NCO courses to better prepare soldiers for the needs of field units. This effort is a concrete example of how the OA program works to improve individual soldier performance and readiness.

Task Knowledges Commonality Analysis Method (TKCAM):

In FY99, the OA program adapted a new MOS design process using an ARI developed methodology called the TKCAM. TKCAM is an analytical method to determine the commonality between two or more MOS in terms of the knowledge soldiers need to perform their jobs. Using TKCAM's commonality analysis methodology, a personnel analyst can identify whether the knowledge requirements for job performance of two or more MOS are similar or different.

In 1999, the U.S. Army Infantry School and Center used TKCAM to assess the feasibility of merging 30,000 Infantrymen assigned to two different MOS.

Computer Assisted Survey Development & Administration

Computer automation makes it easier to obtain, manipulate, interpret, and present occupational information to customers. The time required to estimate the knowledge and skills of soldiers, produce a survey, and collect, analyze, and report the data can be cut in half by using computerized systems. This amounts to substantial savings in time and cost. Currently, the OA staff uses electronic surveys that are developed and delivered on Windows-based PCs, making it easier to re-use survey items through repeated use of standardized questions for follow-on projects with the same customers. The OA program uses a variety of descriptive statistical tools, methods, and analyses and provides graphics in succinct formats that convey immediate meaning to customers.

Internet Surveys

The OA program is evaluating commercial off-the-shelf software for Web-based occupational data collection. In fact, the OA program is currently testing Internet surveys for OA collection with studies for the U.S. Army Sergeants Major Academy and several TRADOC schools.

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